attended the classes during the last winter session. Of these, 35 came up for examination in May, and 23 passed. Several of these obtained very advanced success in more than one subject, so that the total number of successful candidates in the seven subjects taught amounts this year to 49, including four outside candidates, leaving an increase of 13 from last year. Mr. Ethelbert Dowlen, one of the pupils, has been awarded the "Queen's Silver Medal" in botany, and besides numerous other prizes and certificates, he also obtained the "Queen's Gold Medal" for geology at St. John's College, Woking. Altogether these classes seem to have been highly successful, and we hope they will continue to be increasingly so. The classes will be re-opened for instruction on Tuesday, 27th inst., and will be continued every Monday and Wednesday evening for Physical Geography, and on Tuesdays and Fridays, from 6 to 9 P.M., in the other subjects. A class will be held on Saturdays for ladies, in Botany, at a convenient time, commencing from the 11th inst. at 11 A.M. Proposed Subjects:—1, Mathematics (1st, 2nd, and 3rd stage), or theoretic mechanics; 2, sound, light, and heat; 3, magnetism and electricity; 4, chemistry, inorganic; 5, animal physiology; 6, elementary botany; 7, biology; 8, physical geography. The fees are very moderate.

THE volume of Artizans' Reports upon the Vienna Exhibition, published by the Society for the Promotion of Scientific Industry, Manchester, will be published about the 20th of this month. There are thirty-six reports, which are said to be of a very high class character.

WE are glad to see, from the Report of the Chester Society of Natural Science, that that Society, which has concluded its second year, continues to increase in prosperity so far as numbers are concerned—the number of members being now 454. Among these are not a few working members; and the secretary gives excellent advice in counselling each member to devote himself to a special subject, as thus only can the interest of the Society and the advance of science be best promoted. During the past year two societies of natural science have been founded in the neighbourhood of Chester—one at Wrexham, the other at Whitechurch. The Chester Society does its work by means of field excursions, general lectures, and sectional meetings.

THE forthcoming number of Petermann's *Mittheilungen* will contain a detailed account of Captain Hall's *Polaris* Arctic expedition, with its scientific results. It will be accompanied by a carefully constructed map showing the course of the *Polaris* from the 80th degree northwards, her course southward from Aug. 15 to Oct. 15, 1872, the course along which the floe containing the nineteen persons drifted after they were separated from the ship on the night of Oct. 15, 1872, until they were picked up off the coast of Labrador six months afterwards, the distance drifted each day, along with the state of the weather, and the places where seals, &c. were obtained, being indicated; and lastly, the course taken by the men who were picked up in Melville Bay last June.

SHORTLY before his death the late Colonel J. W. Foster completed the manuscript of a work upon the prehistoric races of the United States, which has just made its appearance from the press of S. C. Griggs and Co., of Chicago. This contains an excellent summary of the present state of our knowledge of the aborigines of North America, as illustrated by the remains found in mounds, shell heaps, and ancient mines, as well as by their crania.

THE City of London College, Leadenhall Street, to judge from the programme we have received, offers excellent opportunities to young men engaged during the day for obtaining a good education, literary and scientific, and for intellectual improvement in various ways.

THE *Times of India* says that a scientific geographical survey of native Sikkim is in contemplation by the authorities.

THE *Geological Magazine* announces the death of Prof. Dr. Kemp of Darmstadt, a distinguished zoologist and palæontologist, whose name is well known in connection with the discovery of the *Dinotherium*.

HERR SCHLOENBACH, proprietor of certain salt works at Lieberhall, in Hanover, has instituted a foundation of 12,000 florins, the interest of which is to be devoted to assist geologists who may undertake journeys of exploration beyond the Austro-Hungarian empire. This is intended as a memorial tribute to his son, a young German geologist of much promise, recently deceased.

THE additions to the Zoological Society's Gardens during the last week include an Arctic Fox (*Canis lagopus*) and an Iceland Gull (*Larus leucopterus*), European, presented by Mr. B. L. Smith; a Black-handed Spider-monkey (*Ateles melanochir*) from South America, presented by Mr. B. Went; an African Civet Cat (*Viverra civetta*), presented by Lady Cust; a Macaque Monkey (*Macacus cynomolgus*) from Africa, presented by Capt. Denison; a Raccoon (*Procyon lotor*) from North America, and a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Miss Breach.

THE BRITISH ASSOCIATION

SECTIONAL PROCEEDINGS

SECTION A.—MATHEMATICS

On the Introduction of the Decimal Point into Arithmetic, by J. W. L. Glaisher, B.A.

The following is an extract from Peacock's excellent History of Arithmetic, in the "Encyclopædia Metropolitana," which forms the stanndard (not to say the only) work on the subject. Speaking of Stevinus's "Arithmétique," Peacock writes: "We find no traces, however, of decimal arithmetic in this work, and the first notice of *decimal*, properly so called, is to be found in a short tract, which is put at the end of his 'Arithmétique,' in the collection of his works by Albert Girard, entitled 'La Disme.' It was first published in Flemish, about the year 1590, and afterwards translated into barbarous French by Simon of Bruges. . . . Whatever advantages, however, this admirable invention, combined as it still was with the addition of the exponents, possessed above the ordinary methods of calculation in the case of abstract or concrete fractions, it does not appear that they were readily perceived or adopted by his contemporaries. . . . The last and final improvement in this *Decimal Arithmetic*, of assimilating the notation of integers and *decimal* fractions, by placing a *point* or *comma* between them, and omitting the exponents altogether, is unquestionably due to the illustrious Napier, and is not one of the least of the many precious benefits which he conferred upon the science of calculation. No notice whatever is taken of them in the 'Mirifici Logarithmorum Canonis Descriptio,' nor in its accompanying tables, which was published in 1614. In a short abstract. however, of the theory of these logarithms, with a short table of the logarithms of natural numbers, which was published by Wright, 1616, we find a few examples of decimals expressed with reference to the decimal point; but they are first distinctly noticed in the 'Rabdologia,' which was published in 1617. In an 'Admonitio pro decimali Arithmetica,' he mentions in terms of the highest praise the invention of Stevinus, and explains his notation; and without noticing his own simplification of it, he exhibits it in the following example, in which it is required to divide 861094 by 432. . . . The quotient is 1993,273, or $1993{,}2'7''3'''$, the form under which he afterwards writes it, in partial conformity with the practice of Stevinus. The same form is adopted in an example of abbreviated multiplication, which subsequently occurs. . . . The preceding statement will sufficiently explain the reason why no notice is taken of *decimals* in the elaborate explanations which are given by Napier, Briggs, and Kepler, of the theory and construction of logarithms; and indeed we find no mention of them in any English author between 1619 and 1631. In that year the 'Logarithmicall Arithmetike,' was published by Gellibrand, and other friends of Briggs, who died the year before, with a much more detailed and popular explanation of the doctrine of logarithms than was to be found in the 'Arithmetica Logarithmica.' It is there said . . . From this period we may consider the decimal arithmetic as fully established, inasmuch as the explanation of it began to form an essential part of all books of practical Arithmetic. The simple method of marking the separation of the decimals and integers by a comma, of which Napier has given a solitary example, was not however generally adopted." . . .

De Morgan ("Arithmetical Books," 1847, p. xxiii.) writes: "Dr. Peacock mentions Napier as being the person to whom the introduction [of the decimal point] is unquestionably due; a position which I must dispute upon additional evidence. The inventor of the single decimal distinction, be it point or line, as in 123·456, or 123 | 456, is the person who first made this distinction a permanent language; not using it *merely as a rest in the process*, to be useful in pointing out afterwards how another process is to come on, or language is to be applied, but making it his final and permanent indication as well of the way of pointing out where thei ntegers end and the fractions begin, as of the manner in which that distinction modifies operations. Now first I submit that Napier did not do this; secondly, that if he did do this, Richard Witt did it before him."

De Morgan then states that he has not seen Wright's translation of 1616, but he proceeds to examine Napier's claim as resting on the two examples in the "Rabdologia," in the first of which a comma is used, but only in one place. After this examination he proceeds, "I cannot trace the decimal point in this: but if required to do so, I can see it more distinctly in Witt, who published four years before Napier. But I can hardly admit him to have arrived at the notation of the decimal point. . . ."*

I agree with De Morgan in all that he has stated in the above extracts, and do not think that the single instance of the comma used in the course of work, and replaced immediately afterwards by exponential marks, is a sufficient ground for assigning to Napier the invention of the decimal point, or even affords a presumption that he made use of it at all in the expression of results.

Still one of the objects of this paper is to claim (provisionally of course, till evidence of any earlier use is produced, if such there be) the invention of the decimal point for Napier, but not on account of anything contained in the "Rabdologia." The mathematical works published by Napier in his life-time (he died in 1617) were his "Mirifici Logarithmorum Canonis Descriptio," 1614, containing the first announcement of the invention of logarithms, and the "Rabdologia," 1617, giving an account of his almost equally remarkable (as it was thought at the time) invention of numbering rods or "bones." In 1619, two years after his death, the "Mirifici Logarithmorum Canonis Constructio," containing the method of construction of the canon of logarithms was published, edited by his son, and in this work the decimal point is systematically used in a manner identical with that in which we employ it at the present day. I can find no traces of the decimal point in Wright's translation of the "Descriptio," 1616; and, as De Morgan says, the use of the decimal separator is not apparent in Witt. The earliest work, therefore, in which a decimal separator was employed seems to be Napier's posthumous work, the "Constructio" (1619), where the following definition of the point occurs on p. 6. "In numeris periodo sic in se distinctis, quicquid post periodum notatur fractio est, cujus denominator est unitas cum tot cyphris post se, quot sunt figuræ post periodum. Ut 10000000·04 valet idem, quod $10000000\frac{4}{100}$. Item 25·803, idem quod $25\frac{803}{1000}$. Item 9999998·0005021, idem valet quod $9999998\frac{5021}{10000000}$, et sic de cæteris." On p. 8 we have 10·502 multiplied by 3·216, and the result found to be 33·774432; and on pp. 23 and 24 occur decimals not attached to integers, viz. ·4999712 and ·0004950. These show that Napier was in possession of all the conventions and attributes that enable the decimal point to complete so symmetrically our system of notation, viz. (1), he saw that a point or separatrix was quite enough to separate integers from decimals, and that no signs to indicate primes, seconds, &c., were required; (2), he used ciphers after the decimal point and preceding the first significant figure, and (3), he had no objection to a decimal standing by itself without any integer. Napier thus had complete command over decimal fractions and understood perfectly the nature of the decimal point, and I believe (except perhaps Briggs) he is the first person of whom this can be said. When I first read the "Constructio," I felt some doubt as to whether Napier really appreciated the value of the decimal point in all its bearings, as he seemed to have regarded it to some extent as a mark to separate figures that were to be rejected from those that were to be retained; but a careful examination has led me to believe that his views on the subject were pretty nearly identical with those of a modern arithmetician. There are perhaps 200 decimal points in the book, affording abundant evidence on the subject.

The claim of Napier to the invention of the decimal point is not here noticed for the first time, as both Delambre ("Hist. de l'Astron. mod. t. i. p. 497) and Hutton allude to the decimal fractions in the "Constructio" (though the latter claims priority for Pitiscus), and Mr. Mark Napier ("Memoirs of John Napier," p. 454) devotes a good deal of space to it.

Briggs also used decimals, but in a form not quite so convenient as Napier; thus, he writes 63·0957379 as $63\underline{0957379}$, viz., he prints a bar under the decimals: this notation first appears without any explanation, in his "Lucubrationes" appended to the "Constructio."* Briggs used this notation all his life (he died in 1631), and he explains it in the "Arithmetica Logarithmica" of 1624. Oughtred's symbol first used (as far as I know), in his "Arithmeticæ in numeris"...Clavis, 1631, differed only from Briggs's in the insertion of a vertical bar to separate the decimals from the integers more completely, thus: $63\,|\underline{0957379}$. Oughtred's and Briggs's notation are essentially the same, the improvement of the former being no doubt due to the uncertainty that sometimes might be felt as to which was the first figure above Briggs's line.

From an inspection of MSS. of Briggs and Oughtred (the Birch MSS. contain a letter of Briggs's to Pell, and the Royal Society has a Peter Ramus with many of his MS. notes, while the Cambridge University copy of the "Constructio" is annotated in MS. by Oughtred), it is apparent that in writing, Briggs and Oughtred both made the separating rectangle in exactly the same way, viz., they wrote it $63\,\lfloor\underline{0957379}$, the upright mark usually being just high enough to fix distinctly what two figures it was intended to separate, and rarely took the trouble to continue the horizontal bar to the end of the decimals, if there were many. Thus Oughtred was a follower of Briggs, and only made an improvement in the *printed* notation. It is clear that in writing Briggs's rectangle was pretty nearly as convenient as Napier's point, and there is every probability that Briggs appreciated all the properties of the "separatrix" as clearly as Napier; but in his 8 pp. of "Lucubrationes" he has left much less to judge by than has Napier. In 1624, as we can see from his "Arithmetica Logarithmetica," he had full command over decimal arithmetic in its present form (except that he used the rectangular "separatrix" instead of the point). Gunter was a follower of Napier, and employed the point (but see De Morgan). In his "Description and Use of the Sector" (1623), he uses the point throughout pretty much as we do at present (*e.g.* p. 41 of the "First Booke of the Crosse-staffe": "As 4·50 unto 1·00 : so 1·000 unto 0·222"), except that he calls the decimals *parts* in the text. In Roe's "Tabulæ Logarithmicæ, or Two Tables of Logarithme" (1633), the explanatory portion of which was written by Wingate, decimal points are used everywhere; thus we have (p. 29): "As 1 is to ·079578 : so is the square of the circumference to the superficial content," and he takes the case of circumference 88·75, and obtains by multiplication (performed by logarithms) 626·8 for the result. Wingate refers for explanation on the decimal point to his arithmetic, but I have not seen any edition of this work that was published previously to Roe's tables (Watt gives one, 1630). In his "Construction and Use of the Line of Proportion" (1628), Wingate also uses decimals and decimal points.

On the whole, therefore, it appears that both Napier and Briggs saw that a mere separator to distinguish integers from decimals was quite sufficient, without any exponential marks being attached to the latter; but that Napier used a simple point for the purpose, while Briggs employed a bent or curved line, for which in print he substituted merely a horizontal bar subscript to the decimals; that Gunter and Wingate followed Napier, while Oughtred adopted Briggs's method and made an improvement in the mode of *printing* it. Napier has left so many instances of the decimal point as to render it pretty certain that he thoroughly appreciated its use; and there is every reason to believe that Briggs had, in 1619, an equal command over his separator, although there are not enough printed instances of that date to prove it so conclusively as in Napier's case (there is no instance in the "Lucubrationes" in which a quantity begins with a decimal point, and there could not well be one). Napier did not use the decimal point in the "Descriptio" (1614), nor in his book of arithmetic first printed under the editorship of Mr. Mark Napier in 1839, and there is only the single doubtful case in the "Rabdologia," 1617, so that there is reason to believe that he did not regard it as generally applicable in ordinary arithmetic. The only previous publication of Briggs's that I have seen was his "Chilias," 1617, which contains no letterpress at all. The fact that Napier and Briggs use different separating notations is an argument against either having been indebted to the other, as whoever adopted the other's views would probably have accepted his separator too. It is doubtful whether, if Napier had written an ordinary arithmetic at the close of his life he would have used his decimal point. Wingate employed the decimal point with much more boldness, and regarded it much more in the light of a permanent symbol of arithmetic than did (or could) Napier. The Napierian point and the Briggian separator differ but little in writing, and as far as MS. work is concerned it is quite easy to see why many should have considered the latter preferable, for it was clear and interfered with no existing mark. A point is the simplest separator possible, but it had already another use in language. In all the editions of Oughtred's "Clavis" (which work held its ground till the beginning of the last century) the rectangular separator was used, and it is not unlikely that it was ultimately given up for the same reason as that which I believe will lead to the abandonment of the similar sign now used in certain English books to denote factorials, viz., because it was troublesome to *print*. But be this as it may, it is not a little remarkable that the first separator used (or more strictly, one of the first two) should have been that which was finally adopted after a long period of disuse. All through the seventeenth century exponential works seem to have been common, on which see the accounts in Sir Jonas Moore's "Moor's Arithmetick," London, 1660, p. 10; and Samuel Jeake's "Compleat Body of Arithmetick," London, 1701 (written in 1674), p. 208, which are unfortunately too long to quote in this abstract. In his account Peacock is inaccurate in saying that the "Logarithmicall Arithmetike" was published by Gellibrand and others, the mistake having arisen, no doubt, from a confusion with the "Trigonometria Britannica," 1633; and in any case the reference is not a good one, as the "Arithmetike" of 1631 shows (for reasons which must be passed over here) a less knowledge of decimal arithmetic than do any of the chief logarithmic works of this period. Also Briggs died in 1631, not 1630.

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* In an essay "On some points in the History of Arithmetic" (Companion to the Almanac for 1851), De Morgan has further discussed the invention of the decimal point, but in the same spirit as regards Napier. He seems never to have seen Napier's "Constructio" of 1619, and the work is very rare. The only copy I have been able to see is that in the Cambridge University Library.

* A curious blunder is made in Bartholomew Vincent's reprint of the "Constructio," Lyons, 1620 (of which there is a copy in the Royal Society's library). The printer, unaware that the position of Briggs's subscript bars had any meaning, has disposed them symmetrically under all the figures.

There is no doubt, whatever, that decimal tractions were first introduced by Stevinus in his tract, "La Disme." De Morgan ("Arithmetical Books," p. 27) is quite right in his inference that it appeared in French in 1585, attached to the "Pratique d'Arithmétique." A copy of this work (1585) with "La Disme" appended, is now in the British Museum. On the title-page of the "Disme" are the words "Premierement descripte en Flameng, et maintenant conuertie en Francois, par Simon Stevin de Bruges." These words appearing also in Albert Girard's collected edition of Stevinus's works (1634) no doubt gave rise to De Morgan's inference that "the method of decimal fractions was announced before 1585 in Dutch." The Cambridge University Library possesses a 1585 copy, entitled "De Thiende… Beschreven door Simon Stevin van Brugghe….Tot Leyden. By Christoffel Plantijn, M.D. LXXXV." (privilege, dated December 20, 1584), and there seems every reason to believe, in the absenc of any evidence to the contrary, that this was the first edition of this celebrated tract. Peacock's statement that "it was first published in Flemish about the year 1590, and afterwards translated into barbarous French by Simon of Bruges" is also, I suspect, founded on no other evidence than the sentence on the title-page of the "Disme," which appears also in Girard. De Morgan rightly remarks that Simon of Bruges is Stevinus himself, but he cannot tell whence Peacock derived the date 1590. It is probable that it was merely a rough estimate obtained by considering the dates of the other works of Stevinus.

Stevinus's method involved the use of his cumbrous exponents. Thus he wrote 27·847 as 27(0)8(1)4(2)7(3)[*] and read it 27 commencements, 8 primes, 4 seconds, 7 thirds; and the question chiefly noticed in this abstract is the consideration of who first saw that by a simple notation the exponents might be omitted, and introduced this abbreviation into arithmetic.

Napier's "Rabdologia" was translated into several languages soon after its appearance, and I have taken some pains to examine the different ways in which the translators treated the example which Peacock regarded as the first use of the decimal point, as we can thereby infer something with regard to the state of decimal arithmetic in the different countries. Napier (1617) wrote 1993,273 in the work, and $1993,2'7''3'''$ in the text. In Locatello's translation (Verona, 1623) this is just reversed, viz. there is $1993.2'7''3'''$ in the work, and 1993,273 in the text. The Lyons edition (1626) has 1993,273 in the work, and 1993,2(1)7(2)3(3)[†] in the text, while De Decker's edition (Gouda, 1626) has 1993,273 in the work, and in the text 1993(0)2(1)7(2)3(3), the last being exactly as Stevinus would have written it. Ursinus's "Rhabdologia," Berlin, 1623, is not an exact translation, and the example in question does not occur there.

SANITARY PROGRESS[‡]

SANITARY science is a thing of yesterday, comparatively speaking; but sanitary art, the art of preserving the health, whether of individuals or of communities, has been studied and practised for ages. Sanitary science is the latest and highest development of medicine. I say it is the highest branch of medical science because of the extreme importance of its objects, and I may also add of its results. It is the study of the causes of diseases, and it points out the means of preventing them; and I am sure you are all agreed that "prevention is better than cure;" as Rollet of Lyons well said, "Medicine cures individuals, hygiene saves the masses." But while we contrast hygiene (another name for sanitary science) with curative medicine, we must not forget that it is altogether a medical science, and that its great lights have been all medical men (mind, I am not speaking of the art now, but of the science), and this is necessarily so, and always must be so. I have said that sanitary science is the study of the causes of diseases, of the modes in which they originate, and in which they spread from one person or place to another. It is therefore only those who are acquainted with disease, that are competent to deal with it all, and these are those who have made medical science generally their special subject. You sometimes hear it said that medical men don't know much about diseases. Just think what this means; disease has been studied by earnest men in all its various forms for thousands of years; experiences have been recorded, comparisons made; the effects of remedies noted from generation to generation, and yet we are asked to believe that medical men don't know anything about diseases; the thing is absurd on the face of it.

Sanitary science is, then, a medical science, and the most intimate acquaintance with diseases is necessary for its prosecution —I mean for its advancement as a science. Sanitary investigations can only be scientifically conducted by medical men, just as pianos can only be played by musicians. This science is also the latest development of medical science. We must understand simple things before we can study complex ones. It is little use for a boy to study higher algebra until he has mastered the rule of three; and so pathology, or the study of diseased actions, becomes more and more advanced as physiology—the study of normal healthy actions—is more scientifically pursued; while the study of sanitary matters in a scientific way has only become possible of later years from the great advances made in the study of pathology, physiology, and chemistry; but being possible, it has made such rapid strides, and evolved such startling facts with regard to the causes of diseases, that it has become the popular subject of the day. Everyone thinks that he is competent to speak about it, and everyone who wants to make an effective discourse must needs take upon himself to expound

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[*] Stevinus enclosed the exponent-numbers in complete circles, which have been replaced above, for convenience of printing, by parentheses.

[†] These parentheses are printed instead of the circles which appear in these works as in Stevinus.

[‡] Abstract of the Inaugural Lecture delivered at the Town Hall, Birmingham, Thursday evening, Oct. 9, 1873, by Prof. Corfield, M.D. Oxon.